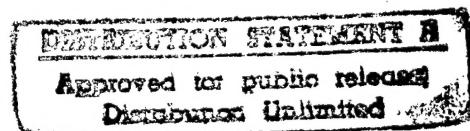


# Limited Energy Study

## Energy Engineering Analysis Program (EEAP)

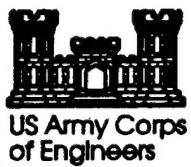
### Fort Knox, Kentucky

#### *Executive Summary*



CONTRACT # DACA27-93-C-0096  
SYSTEMS/CORP PROJECT # 93006.03  
NOVEMBER 5, 1993

**SYSTEMS**  
*corp*  
SYSTEMS ENGINEERING AND MANAGEMENT CORPORATION





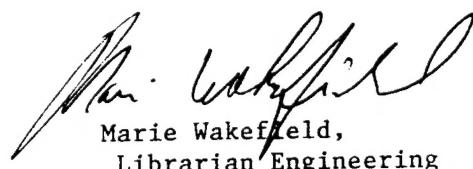
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## **EXECUTIVE SUMMARY**

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## **1 EXECUTIVE SUMMARY**

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### **1.1 SYNOPSIS**

Systems Corp surveyed and completed energy analyses for 37 buildings, and eight ballfields. The energy conservation opportunities (ECOs) evaluated were ceiling reflectance, high efficiency indoor lighting, indoor lighting controls, and ballfield lighting and control systems. Cost estimates were prepared using M-CACES. Life cycle cost analyses were performed using the Life Cycle Cost in Design (LCCID) computer program. Project development brochures (PDBs) and DD1391 forms were prepared for a Energy Conservation Investment Program (ECIP) project. The project that was developed represents \$93,956 in annual savings with favorable simple paybacks and saving to investment ratios (SIRs).

### **1.2 INTRODUCTION**

Systems Engineering and Management Corporation (SYSTEMS/CORP) was contracted by the Louisville District of the United States Army Corps of Engineers in June 1993 to perform a limited energy study for 37 buildings at Fort Knox, Kentucky. In addition, the project includes a ballfield lighting survey of 8 locations.

#### **1.2.1 Scope of Work**

1. Evaluated selected energy conservation opportunities (ECOs) to determine their energy savings potential and economic feasibility.
2. Conduct a limited site survey of selected buildings or areas to insure that any methods of energy conservation which are practical and have not been evaluated in any previous energy study have been considered and the results documented.
3. Determine efficiency of existing systems. Determine the replacement option with the highest SIR.
4. Provide complete programming or implementation documentation for all recommended ECOs.

## 1 EXECUTIVE SUMMARY

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5. Prepare a comprehensive report to document the work performed, the results, and the recommendations.

### 1.2.2 Organization of the Final Report

The submitted material for this report consists of the following:

Volume I: Executive Summary, Methods and Approach, and Programming Document-ECIP Project I

Volume II: Programming Document-ECIP Project (Continued), Scope of Work, Interim Review Meeting Minutes, Interim Review Comments and Responses, and Interim Review Presentation

## 1.3 PRESENT AND HISTORICAL ENERGY CONSUMPTION

The baseline energy consumption and energy conservation opportunity energy consumption were determined using spreadsheets and manual calculating to model system energy consumption. These have been included in *Section 2* of this report.

### 1.3.1 Natural Gas Costs

The natural gas consumption and cost for FY92 (October 1991-September 1992) at Fort Knox are shown in *Table 1.3.1, Fort Knox Natural Gas*. *Figure 1.3.1* is a bar graph of the monthly consumption and costs. The natural gas cost used for evaluating the ECOs is as follows:

$$\text{COST/MBTU} = \$3.74/\text{MBTU}$$

TABLE 1.3.1

# FORT KNOX NATURAL GAS

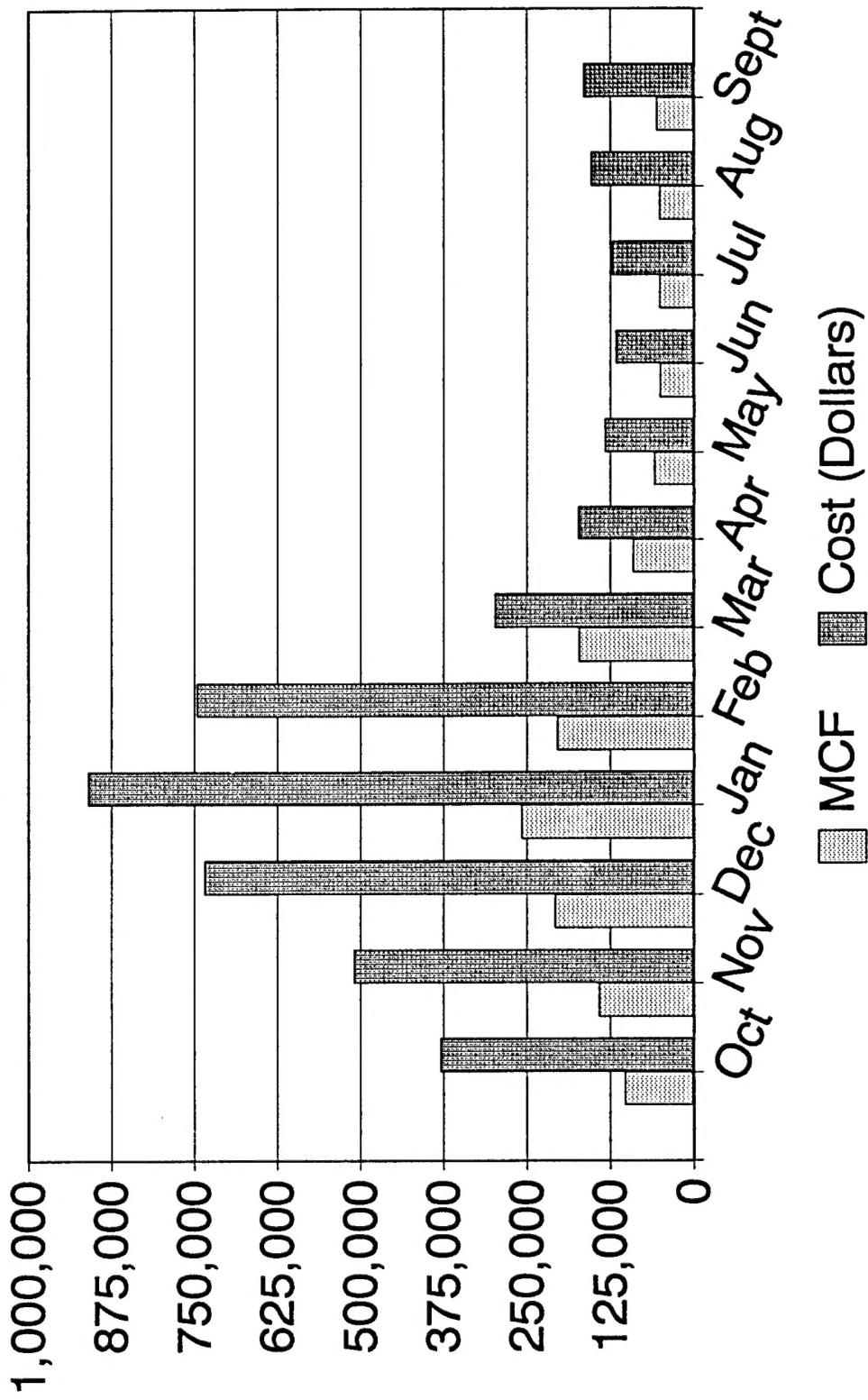
Oct 91 - Sept 92

MONTH	DEMAND	CONSUMPTION MCF	COST	COST/MCF
Oct 91	14,616	103,670	\$379,995	\$3.665
Nov	14,616	141,650	510,079	3.601
Dec	11,000	208,531	734,825	3.524
Jan	11,034	259,223	909,415	3.508
Feb	12,559	205,339	746,795	3.637
Mar	12,559	171,895	297,539	1.731
April	12,559	91,273	172,523	1.890
May	12,559	59,090	133,344	2.257
Jun	12,559	50,734	116,873	2.304
Jul	12,559	51,981	122,570	2.358
Aug	12,559	51,954	154,449	2.973
Sept	12,559	56,458	166,220	2.944
<b>TOTAL</b>	<b>151,738</b>	<b>1,451,798</b>	<b>\$4,444,627</b>	<b>3.06</b>
<i>Min</i>	<i>11,000</i>	<i>50,734</i>	<i>116,873</i>	<i>1.731</i>
<i>Max</i>	<i>14,616</i>	<i>259,223</i>	<i>909,415</i>	<i>3.665</i>
<i>Avg</i>	<i>12,645</i>	<i>120,983</i>	<i>370,385</i>	<i>2.866</i>

FIGURE 1.3.1

# FORT KNOX

FY92 Natural Gas



## 1 EXECUTIVE SUMMARY

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### 1.3.2 Electric Costs

The electric energy consumption, demand, and costs for FY92 are shown in *Table 1.3.2 Fort Knox Electric*. *Figure 1.3.2* is a bar graph of the monthly consumption and cost. The electric cost used to calculate the electric cost savings for the project is as follows:

COST/KWH	= \$0.02506/KWH (No Demand)
COST/MBTU	= \$7.343/MBTU (No Demand)
COST/KW	= \$7.067/KW (Monthly Demand)

### 1.4 ENERGY CONSERVATION OPPORTUNITIES INVESTIGATED

Systems Corp analyzed four energy conservation opportunities (ECOs) at Fort Knox, Kentucky. The analysis was performed utilizing energy models developed by Systems Corp and data collected during the field survey of the facilities at Fort Knox. Each ECO was evaluated to determine the potential energy savings, dollar savings, implementation costs, simple payback, life cycle cost, and savings to investment ratio (SIR). The four ECOs that were evaluated are as follows:

ECO - 1 Ceiling Reflectance

ECO - 2 High Efficiency Indoor Lighting

ECO - 3 Indoor Lighting Controls

ECO - 4 Ballfield Lighting and Controls

Systems Corp's energy analysis models were used to determine the savings achieved for implementing each ECO in the facilities that were evaluated. The U.S Army Corp of Engineers M-CACES software was used to estimate the implementation cost of each ECO in each facility evaluated. The U.S Army Corp of Engineers Life Cycle Cost in Design, Version 1.0, Level 72, software was used to perform life cycle cost analyses and determine the SIR of each ECO for each facility evaluated.

TABLE 1.3.2  
**FORT KNOX ELECTRIC**  
 Oct 91 - Sept 92

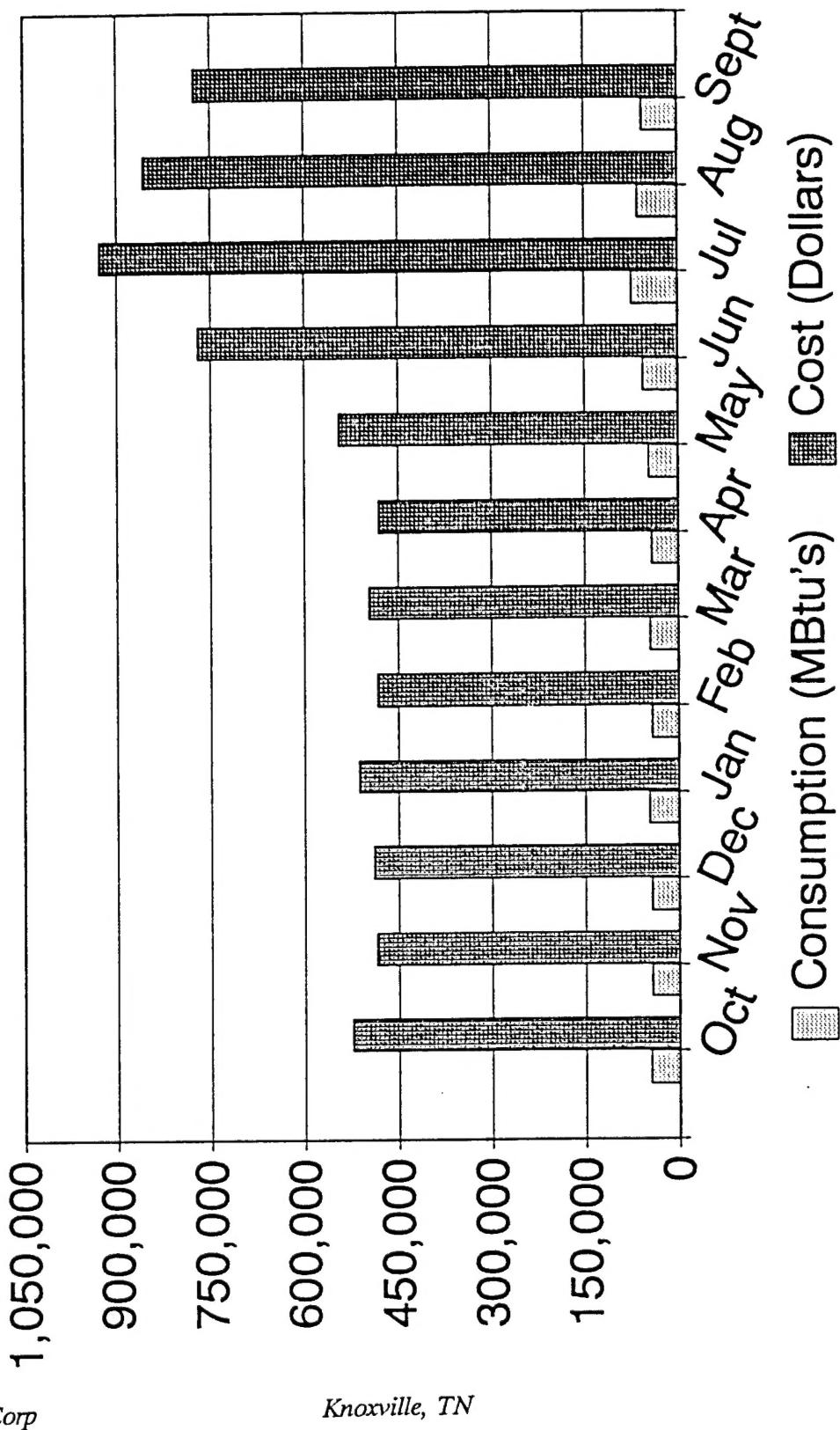
MONTH	DEMAND KW	CONSUMPTION KWH	COST DEM & CONS	COST/KWH
Oct 91	28,950	13,601,000	\$524,094	\$ .039
Nov	24,650	13,109,000	484,546	.037
Dec	24,950	13,205,000	488,850	.037
Jan	25,850	13,954,000	513,317	.037
Feb	25,250	12,886,000	482,755	.037
Mar	24,800	13,579,000	497,273	.037
April	25,100	12,891,000	481,931	.037
May	30,650	14,006,000	545,004	.039
Jun	41,700	16,504,000	769,708	.047
Jul	44,400	21,867,000	927,163	.042
Aug	44,300	19,172,000	858,772	.045
Sept	41,250	16,933,000	776,615	.046
<b>TOTAL</b>	<b>381,850</b>	<b>181,707,000</b>	<b>\$7,350,028</b>	<b>\$ .040</b>
<i>Min</i>	24,650	12,886,000	\$481,931	\$ .037
<i>Max</i>	44,400	21,867,000	927,163	.047
<i>Avg</i>	31,820	15,142,250	612,502	.040

FIGURE 1.3.2

# FORT KNOX

FY92 Electric

Systems Corp



Knoxville, TN

## 1 EXECUTIVE SUMMARY

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### 1.4.1 ECOs Recommended

Systems Corp recommended that the following ECOs be implemented due to favorable simple pay backs and savings investment ratios (SIRs).

ECO - 2 High Efficiency Indoor Lighting

ECO - 3.1 Indoor Lighting Controls (On/Off Photocells)

ECO - 4 Ballfield Lighting and Controls

### 1.4.2 ECOs Rejected

ECO-1, Ceiling Reflectance, was rejected due to the fact that the potential energy savings was found to be quite small for each building that was evaluated. The implementation costs for each building evaluated did not represent a large investment, but when compared to the savings resulted in simple paybacks in excess of thirty years. Improving the ceiling reflectance did not yield an acceptable simple payback in any of the buildings evaluated. ECO-3.2, Dimming and On/Off Photocell Control, was rejected. ECO-3.1, on/off photocell control, has a better SIR and SPB than ECO-3.2.

### 1.4.3 ECIP Projects Developed

Systems Corp developed one ECIP project. The project include the improvement of lighting efficiency in 16 buildings, installation of lighting controls in 23 buildings, and the improvement of lighting efficiency at 3 ballfields and lighting control at 8 ballfields. The following table summarizes the savings and investment for each ECO included in the ECIP project.

TABLE 1.4.3

ECIP PROJECT SUMMARY

	1st Yr Savings	Investment	SIR	SPB(yrs)
ECO-2 INDOOR LIGHTING EFFICIENCY	\$50,872	\$277,658	2.08	5.46
ECO-3.1 INDOOR LIGHTING CONTROLS	\$38,595	\$113,162	3.88	2.93
ECO-4 BALLFIELD LIGHTING & CONTROLS	\$4,489	\$20,122	2.60	4.48
<b>TOTAL ECIP PROJECT</b>	<b>\$93,956</b>	<b>\$410,942</b>	<b>2.61</b>	<b>4.37</b>

1st Yr  
Energy  
Savings, MBTU